Towards a carbon budget for the Louisiana continental shelf

Role of water column primary production and respiration

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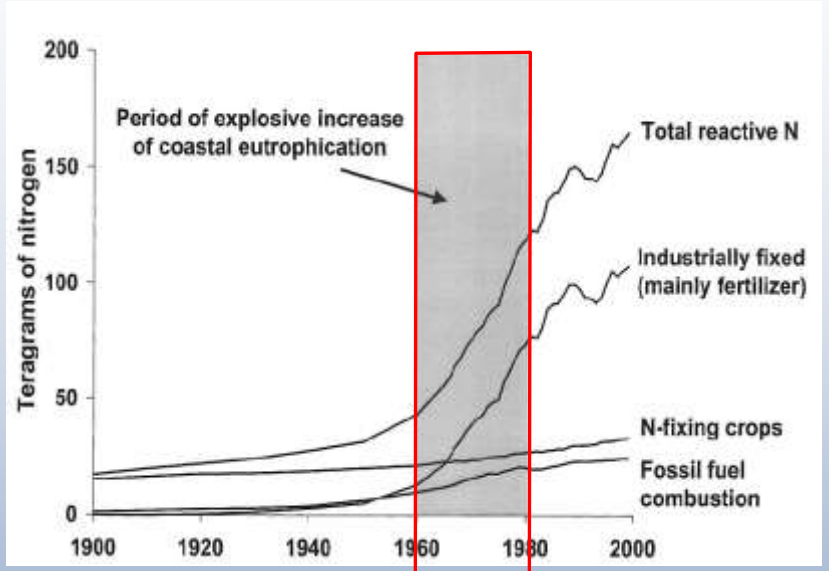
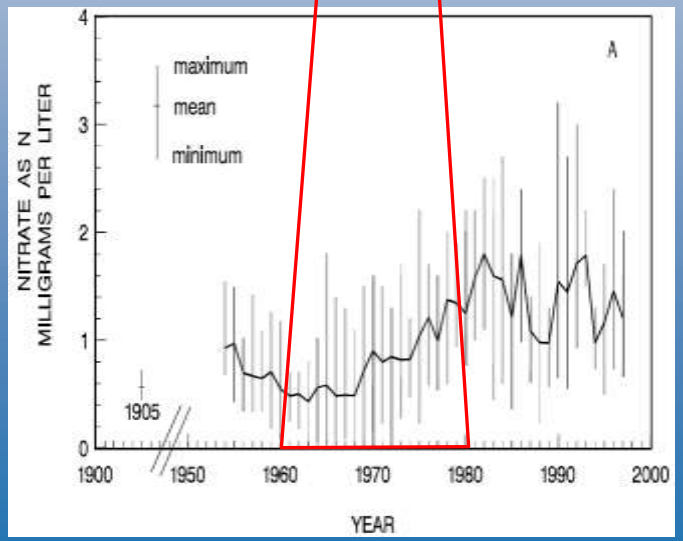
Mississippi –Atchafalaya River Basin

Fertilizer use coincides with river nitrate ~1960-1980

Worldwide fertilizer use
(Boesch 2002)



Mississippi River Nitrate
(Goolsby et al. 1999)



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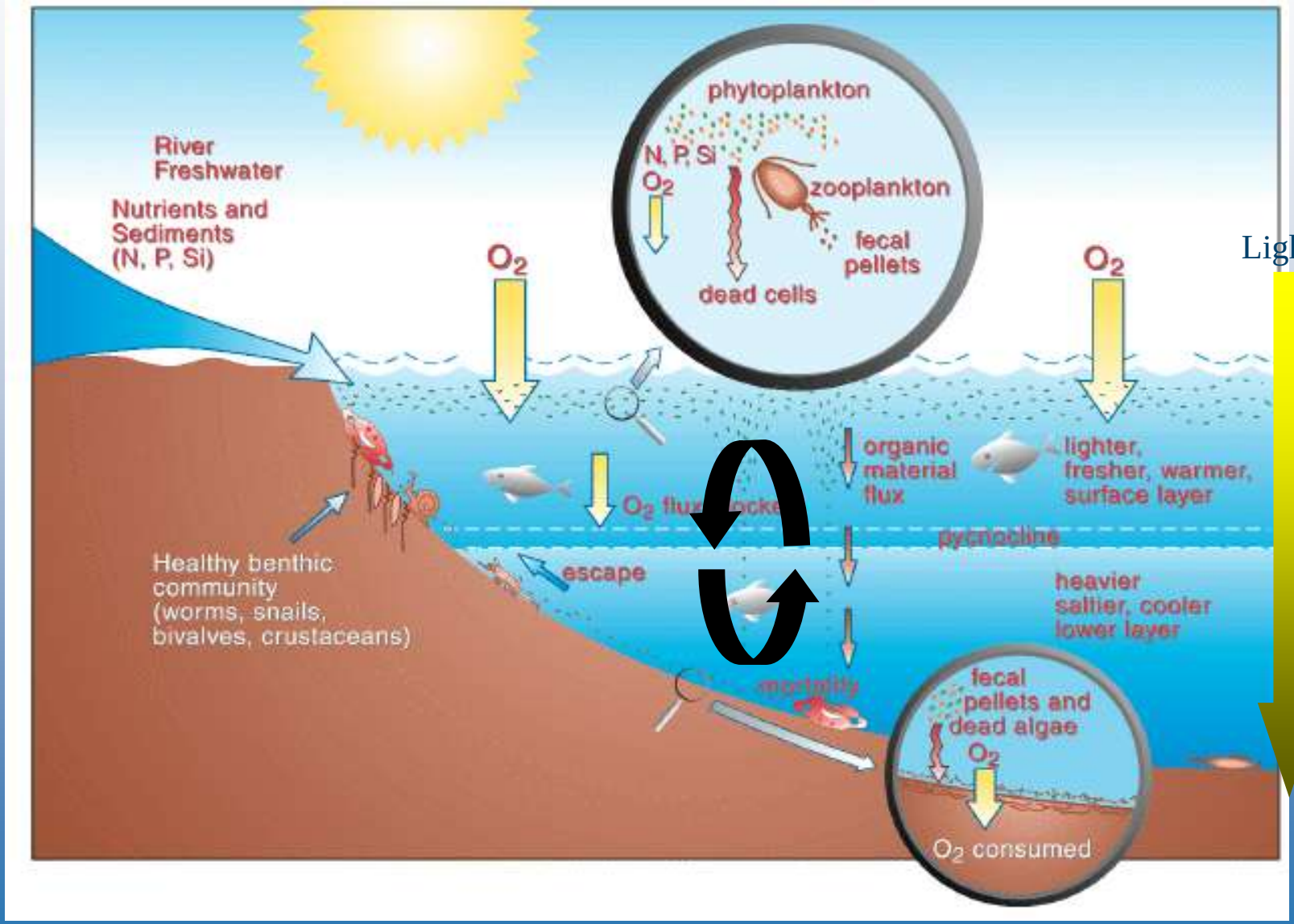
Eutrophication-Hypoxia Paradigm



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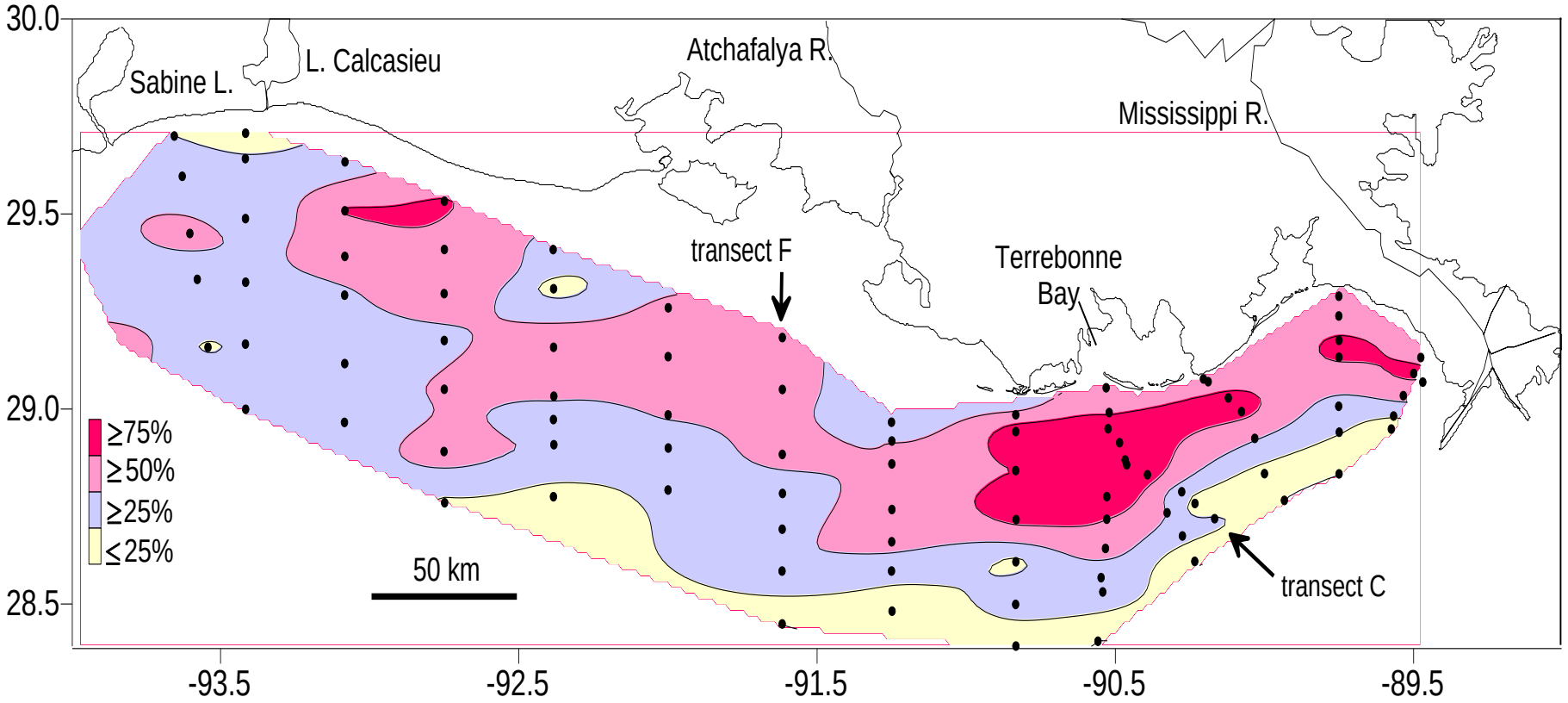
Hypoxia occurs on the Louisiana shelf every summer



1985 – 2002 Frequency

Source: Nancy Rabalais

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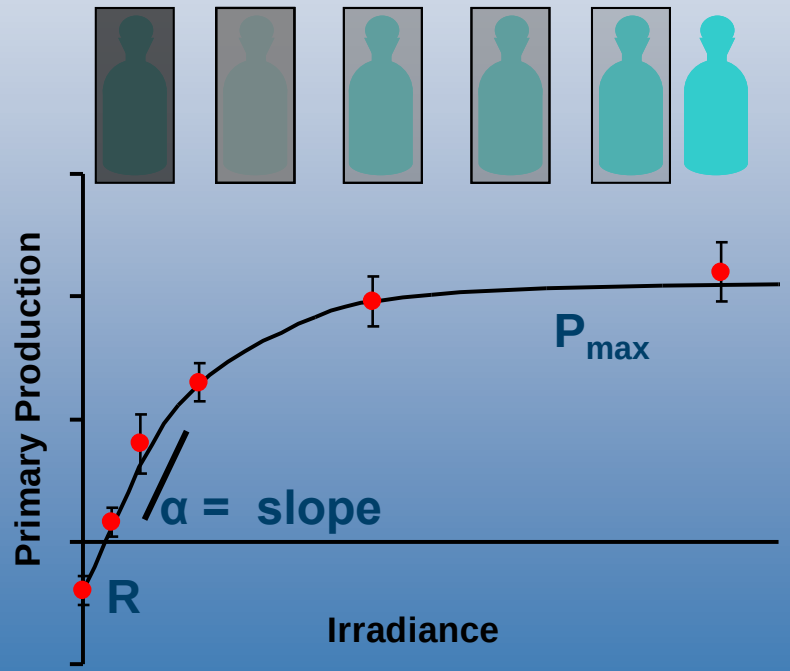
Questions

- **Do current nutrient loads cause accumulation of organic matter on the Louisiana Shelf?**
  - Net autotrophic? Production exceeds respiration
  - Contributes to Legacy effect?
    - (e.g., Turner et al. 2006, 2008, 2012)
  - Lag time between nutrient reductions and observable changes in hypoxia (e.g., Greene et al. 2009)

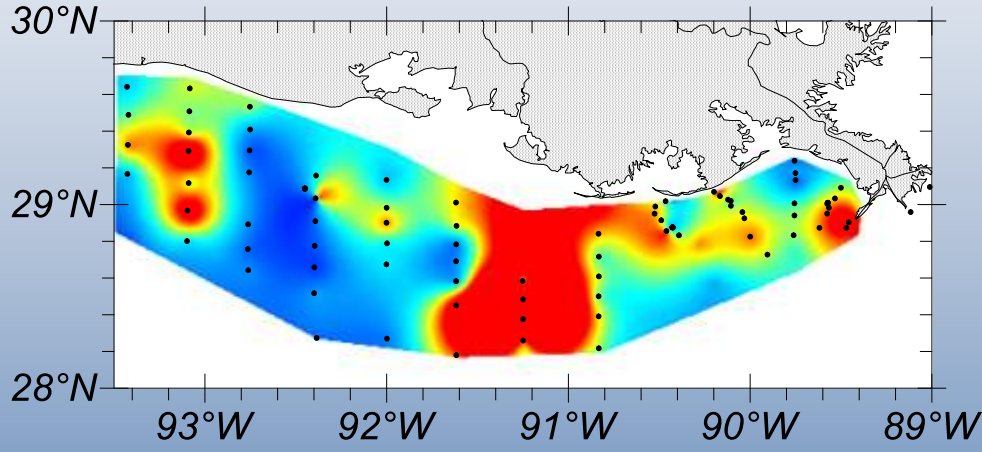
- **What is the role of terrestrial- and phytoplankton-OM supporting observed respiration?**
  - Benthic and water column respiration
    - Murrell and Lehrter 2011, Lehrter et al. 2012, Murrell et al. 2013

Primary Production

- 7 Cruises, shelfwide coverage
- Mar, Apr, Jun, Aug, Sept
- 600 measurements
- Lehrter et al. 2009



$$P = P_{\max}(1 - e^{\alpha I / P_{\max}}) - R$$

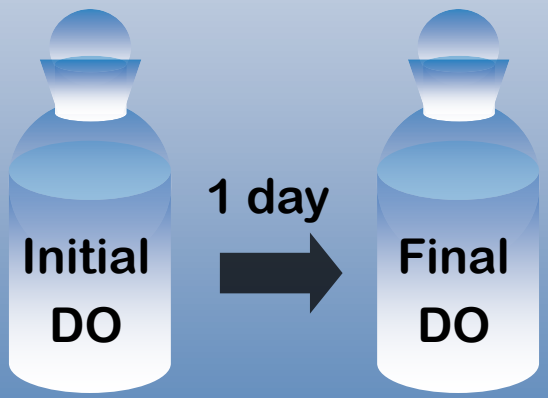


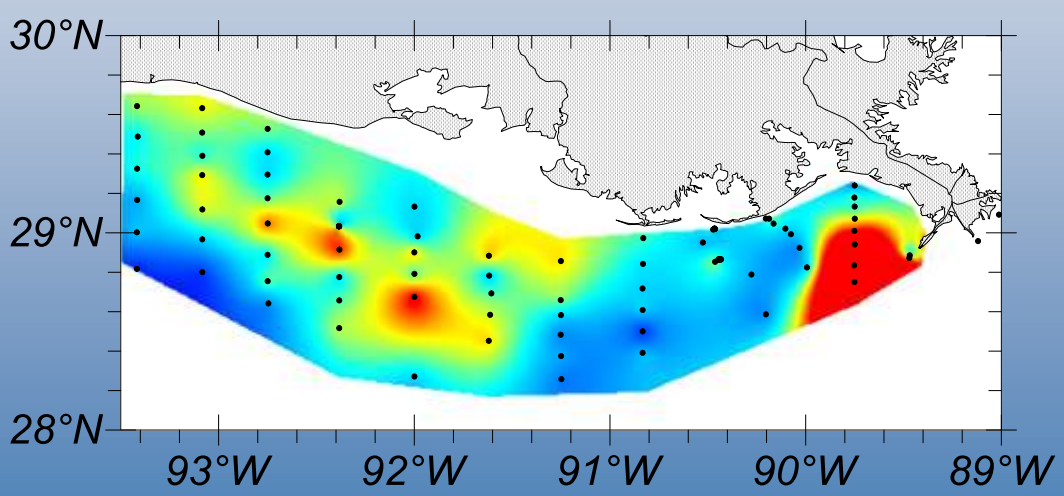
Aug 2007

168 mmol C $m^{-2}d^{-1}$

Plankton Community Respiration

- 10 Cruises, shelfwide coverage
- Mar-Sept
- Surface layer and bottom layer
- >1200 measurements
- Murrell et al. 2013, *Cont. Shelf. Res.*



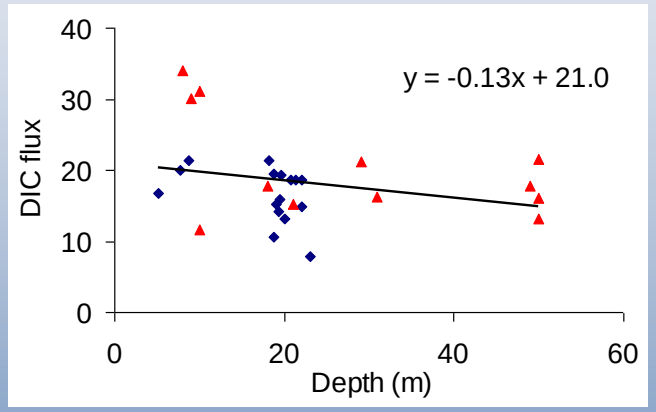


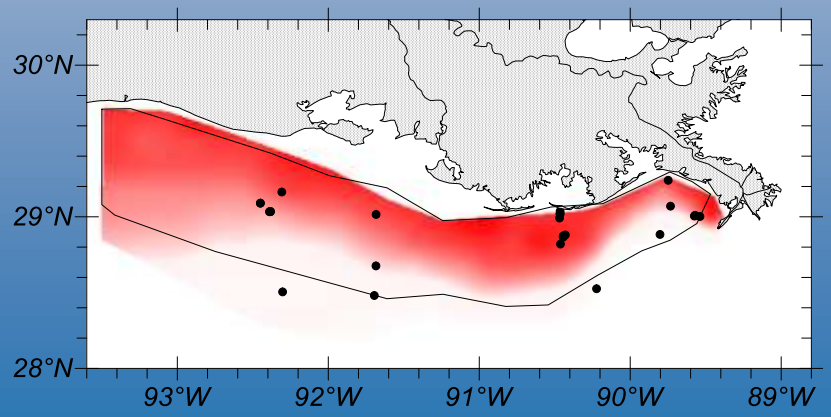
Aug 2007

175 mmol $m^{-2}d^{-1}$

Benthic Respiration

- 6 Cruises, 27 stations
- DIC fluxes
- Lehrter et al. 2012 *Biogeochemistry*
- *Range 8-34 mmol m^{-2} d^{-1}*





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Summary of Production & Respiration

Cruise	Prod (mmol $m^{-2}d^{-1}$)	WC+Benth Resp (mmol $m^{-2}d^{-1}$)	Net (mmol $m^{-2}d^{-1}$)	*P:R*
Mar 2005	124	212	-88	0.58
Sept 2005	62	120	-59	0.51
Apr 2006	116	154	-38	0.75
Jun 2006	89	178	-89	0.50
Sept 2006	138	150	-12	0.92
May 2007	98	193	-94	0.51
Aug 2007	168	193	-25	0.87
Average	114	171	-58	0.66

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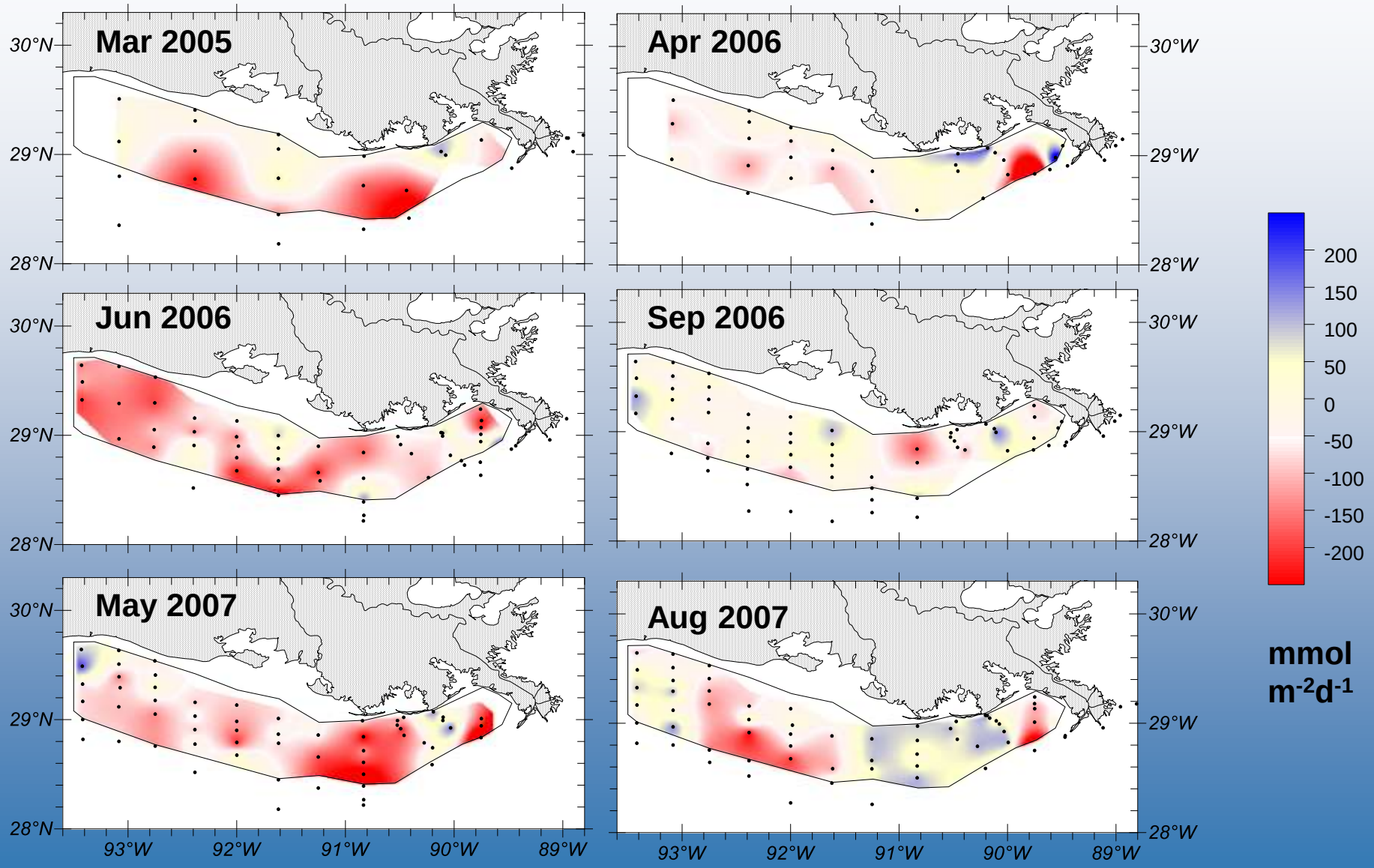
Net Metabolism



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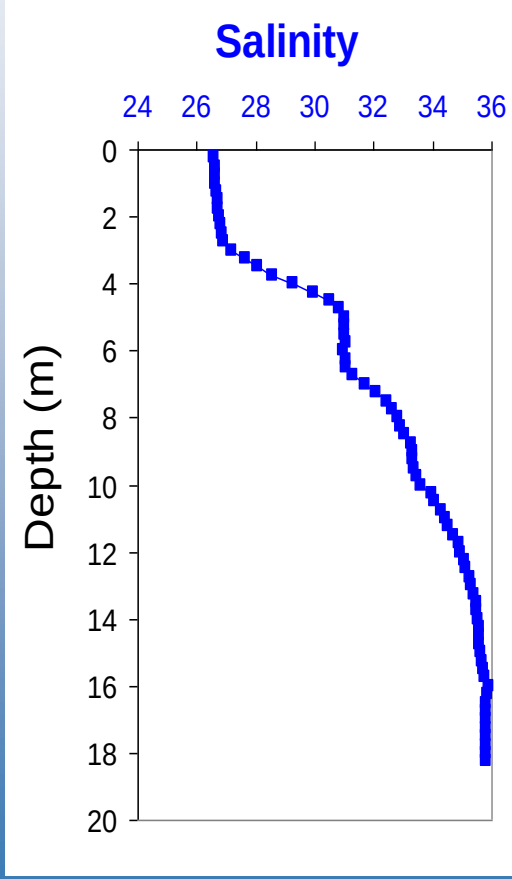
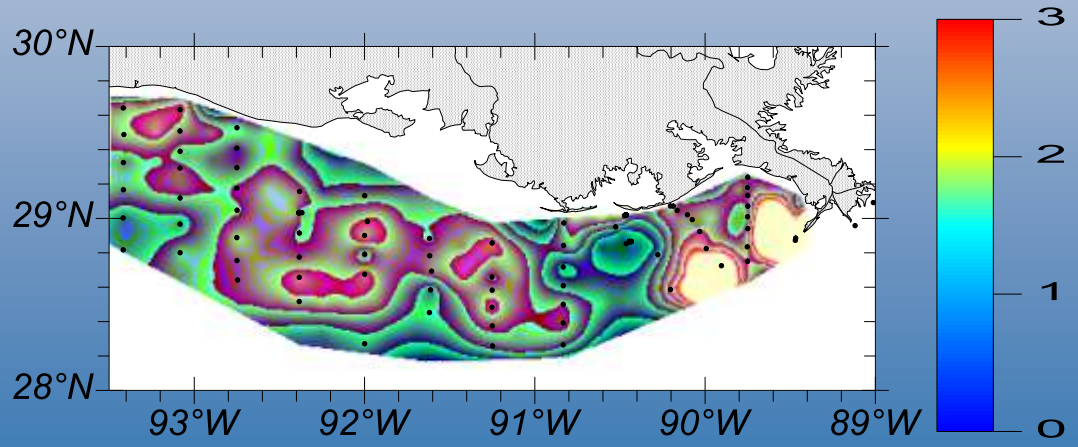
Freshwater Residence Times

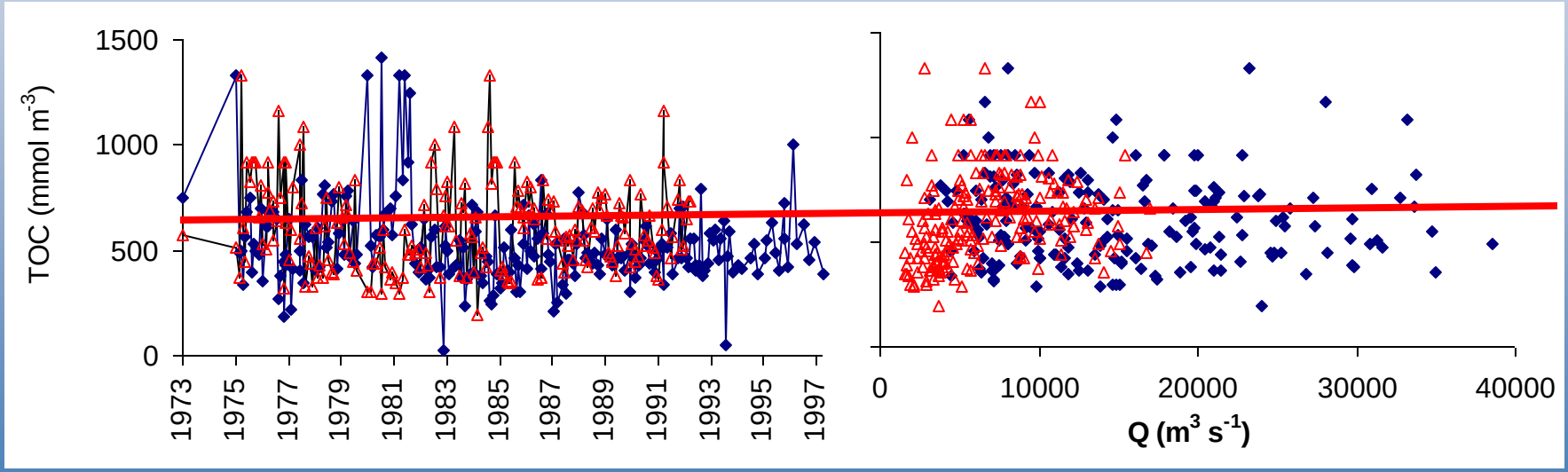


- FFW = (36.5-S)/36.5
- FW volume = FFW * depth * area
- Assume 100% of river water enters domain
- T_{FW} = FW volume / Q_{30}



River organic matter turnover

- River water TOC: 550 mmol C m^{-3}
- T_{TOC} = [TOC] * FW volume / R
- Assume TOC 100% labile



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Turnover times of freshwater and TOC

Cruise	T_{FW} (d)	T_{TOC} (d)	Ratio
Mar 2005	32	6.1	0.19
Apr 2006	24	4.5	0.19
Jun 2006	35	4.5	0.13
Sept 2006	124	7.2	0.06
May 2007	22	3.7	0.17
Aug 2007	58	5.8	0.10
Average	49	5.3	0.14

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Carbon Sources

Cruise	Primary Production *in situ*	River TOC	Subsidy
Mar 2005	58%	19%	23%
Apr 2006	75%	19%	6%
Jun 2006	50%	13%	37%
Sept 2006	92%	6%	2%
May 2007	51%	17%	32%
Aug 2007	87%	10%	3%
Average	69%	14%	17%

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Summary / Conclusions

- **Net heterotrophy consistently observed**
  - –Organic C is apparently not stored in system
  - –Organic C inputs from outside the system
    - spatial and/or temporal
- **River TOC minor source**
  - –6-19% of respiratory C demand
- **Primary production major source**
  - –50-92% of respiratory C demand

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Related Talks/Posters

- **Tuesday**
  - SS27
    - 136 Beddick – Sediment porewater chemistry
    - 137 Jarvis - Sediment organic matter deposition
- **Wednesday**
  - **SS05** COASTAL HYPOXIA MODELING
    - 10:45 Yu – O2 dynamics
    - 13:45 DePettro – Light Model
    - 14:00 Feist – DO mass balance model
    - 14:15 Pauer – 1D water quality model
    - 14:30 Ko – High resolution 3D model
  - **SS30**
    - 14:45 Lehrter – O2 dynamics at the sediment-water interface

Thank You!

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